International Journal of Physical Education, Sports and Health 2015; 2(2): 237-241

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 4.69
IJPESH 2015; 2(2): 237-241

www.kheljournal.com
Received: 05-09-2015
Accepted: 08-10-2015

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Breathing techniques- A review

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Abstract
Physiotherapy should be offered to patients with a variety of medical respiratory conditions with the aim of breathlessness management and symptom control, mobility and function improvement or maintenance, and airway clearance and cough enhancement or support. Breathing exercises is used as strategy in Lung expansion therapy, Bronchial hygiene therapy and PT techniques to reduce work of breathing. Breathing exercises can be classified as inspiratory and expiratory as some exercise stresses more of inspiration while some stresses expiration. Breathing exercises are used in Restrictive as well as obstructive conditions. In restrictive types of disorders Deep Breathing, Diaphragmatic Breathing, Deep Diaphragmatic Breathing, End – Inspiratory hold, Sustained Maximal Inspiration, Slow Maximal Inspiration, Incentive Spirometer, Sniff, Segmental (Apical and Lateral Costal Activity) are commonly used. Abdominal Breathing, Air Shift Breathing, Glossopharyngeal Breathing are commonly effective in spinal cord injuries. Stacked Breathing, Air Shift Breathing are used in localized and generalised atelectasis of upper lobe respectively. Chest mobility exercises and Belt exercises are used to prevent the formation of disabling adhesions between two layers of pleura. Active cycle breathing technique and Autogenic Drainage are commonly used for clearance of secretions. Breathing Control Technique, Innocenti Technique, Pursed Lip Breathing are used during acute exacerbation and End – Expiratory hold, Buteyko Breathing, Exhale With Activity, Stressed Respiratory Exercises, Panting, Pacing are commonly used when the subjects are in stable phase. Inspiratory Muscle Training, Isocapnic Hyper Ventilation, Inspiratory Resistive Training, Inspiratory Threshold Training are used to improve strength and endurance of respiratory muscles. Breathing Cycle Technique is used in chronic hyperventilation where there is breathlessness without an organic cause. This update has made as a result of the need to clarify the effectiveness of different types of breathing exercise in respiratory conditions. This guideline gives valuable information about different types of breathing exercise in management of respiratory conditions to all respiratory physicians and physiotherapists working in respiratory care.

Keywords: Physiotherapy, Breathing exercise, obstructive disease, restrictive disease.

Introduction
Physiotherapy should be offered to patients with a variety of medical respiratory conditions, with the aim of breathlessness management and symptom control, mobility and function improvement or maintenance, and airway clearance and cough enhancement or support. Strategies and techniques include: rehabilitation, exercise testing, and exercise prescription, airway clearance, positioning and breathing techniques [1]. Reduced lung expansion, accumulation of secretions and increased work of breathing are main problems seen with respiratory disorders. Physiotherapists use Lung expansion therapy, Bronchial hygiene therapy and PT techniques to reduce work of breathing to address the above problems [2]. Breathing exercises is an important component in all of the above techniques.

Breathing exercise can be defined as the therapeutic intervention by which purpose full alteration of a given Breathing pattern are categorized as breathing exercises [3]. Outcomes have ranged from to increase lung volume, to clear secretions, to improve gas exchange, to control breathlessness, to increase exercise capacity, to reduce blood pressure, to reduce obesity, relaxation response for stress reduction and to control pain in natural child birth [3, 4, 5].

Breathing exercise can be classified as inspiratory and expiratory. Some of the breathing exercises stresses inspiration thereby increasing lung volume where as others stresses on expiration which assists in clearance of secretions.

In restrictive disorders of lungs, atelectasis, consolidation, pleural effusion and pneumothorax there will be reduction of lung volume and capacities [6].

Therefore the main aim is to improve expansion of lungs. The mechanism of improvement of lung expansion can be due to increase in transpulmonary pressure gradient, boosting collateral ventilation and by physiology of interdependence. Breathing exercises can be given if patient is conscious and cooperative [2].

In restrictive types of disorders Deep Breathing, Diaphragmatic Breathing, Deep Diaphragmatic Breathing, End – Inspiratory hold, Sustained Maximal Inspiration, Slow Maximal Inspiration, [7] Incentive Spirometer, [2] Sniff, [6] Segmental (Apical and Lateral Costal Activity) are commonly used [8]. Abdominal Breathing [9], Air Shift Breathing, [10] Glossopharyngeal Breathing are commonly effective in spinal cord injuries. Stacked Breathing [7], Air Shift Breathing are used in localized and generalised atelectasis of upper lobe respectively. Chest mobility exercises and Belt exercises are used to prevent the formation of disabling adhesions between two layers of pleura [8].

In Deep Breathing subjects were asked to breathe in deeply and slowly through the nose and sigh out through the mouth. Breathing through nose warms and humidifies air but doubles resistance to air flow. Inspiration is slow to decrease velocity and increase the strength of muscle contraction. Expiration is through the mouth to keep the airway open patency of small airway closure [6].

In Diaphragmatic breathing, the subjects were asked to get comfortable position. They were instructed to rest the dominant hand on your abdomen with elbows supported and keeping their shoulder relaxed. Allow their hand to rise gently while visualizing air filling the abdomen like a balloon [8]. Progress this exercises to side lying and relaxed standing. The beneficial effects are improving pulmonary function and ventilation. One of the detrimental effects is decreased efficacy there by increased dyspnea. This may due to inadequate learning; subjects may have to carry out a more consciousness during diaphragmatic breathing and if optimal positioning is not used there will be limited diaphragmatic excursion. The other detrimental effect is paradoxical breathing. In COPD there will be flattening of diaphragm and greater use of accessory muscles so there will be greater pull on upper thorax-inwards which results in paradoxical breathing. Good candidate of COPD will be those who are having mild obstruction with elevated respiratory rate, low tidal volume and abnormal ABG. Poor candidate will be those who are having moderate to severe COPD with marked hyperinflation. Deep diaphragmatic breathing is a combination of deep breathing with diaphragmatic breathing [11].

End – inspiratory technique can be administered along with deep diaphragmatic breathing to further stress the inspiration. By this method air can be entered into poorly ventilated regions. It boosts collateral ventilation. It is not suitable for breathless people [6].

Sniff is a simple and effective technique used to increase diaphragmatic excursion further along with deep diaphragmatic exercises. It augments collateral circulation. Perform the normal diaphragmatic breathing exercise as mentioned above. Then ask the subject to sniff in three times. During exhalation, tell the subjects to let it out slow which help to decrease RR and some relaxation. Progressively decrease the no of sniffs as the day progresses [6].

Hypoventilation does occur in certain areas of the lungs because of chest wall fibrosis, pain, and muscle guarding after surgery, atelectasis and pneumonia. So in these circumstances Segmental exercises can be given to increase localised expansion of the lungs [8]. The techniques used with segmental exercises may elicit localised drop in intra pleural pressure [7] thereby increasing transpulmonary pressure gradient which results in expansion. Manual cues such as vibration or pressure sensation are provided over the regions of chest wall that is not expanding well may also aid in expansion [7, 12, 13]. Three types of segmental breathing that target the apical, lateral and posterior segments of the lower lobes are apical expansion exercises, lateral costal breathing and posterior basal expansion exercises [8].

The following technique further stresses inspiration. First squeeze chest during expiration then stretch at the very end of expiration, allow inspiration to occur. Near the end of inspiration apply a series of 3 or 4 gentle stretches rather similar to repeated contractions [7].

Stacked breathing is the only breathing exercise where there is more inspiratory efforts compared to a single expiratory effort. In this technique subjects have to breathe in 3-4 times without expiration, each time filling the lung a little bit more up to vital capacity. This exercise is better fit for individuals with weak respiratory muscles to achieve full inspiration prior to a cough. A glottis closure between each attempt allows a buildup of extra volume with in the lungs, thereby achieving a good laryngeal control. Stacked breathing technique is also used mainly for localised collapses [7].

In a slow maximal inspiration, subject asked to do slow inspiration for as long as possible. This keeps the glottis open and air can continue to move. This encourages recruitment of all muscle fibers. A sustained maximal inspiration is a slow, deep inhalation from FRC up to the total lung capacity, followed by 5 to 10 sec breath hold. Both of these techniques can increase lung expansion by altering transpulmonary pressure gradient, boosting collateral ventilation and improving the physiology of interdependence. Incentive Spirometry which was developed by Barlett *et al.* uses the principle of sustained maximal inspiration. It was designed to mimic natural sighing or yawning by encouraging the subject to take long slow deep breaths and hold. Types of incentive spirometer are flow oriented and volume oriented spirometer. Volume spirometer indicate volume achieved during sustained maximal inspiration (eg coach spirometer, voldyne) and flow oriented spirometer indicates degree of inspiratory flow (eg Triflo, mediflo) [2]. Contraindications include unconscious subjects, unable to co-operate. Hazards are hyperventilation, hypoxemia, exaggerating bronchospasm.

Abdominal Breathing, Air Shift Breathing, Glossopharyngeal Breathing are commonly effective in improving respiratory function in spinal cord injuries. Glossopharyngeal breathing is indicated in subjects with severe weakness of muscles of inspiration like high spinal cord injury [14]. This technique is often called frog breathing [15] and involves using the tongue to move air into the lungs. Procedure is such that subject takes several gulps of air. Then the mouth is closed, tongue pushes the air back and traps it in the pharynx, air is then forced into the lungs when glottis is opened [8] Each gulp of air delivers 60 to 200 mL of air to the inspiratory volume [16]. Six to nine gulps are stacked together for its effectiveness. This technique increases the depth of inspiration, vital capacity, Peak expiratory flow rate and maximal voluntary ventilation [17].

Abdominal breathing exercise is the only breathing exercise where expiration is done first followed by inspiration. This exercise is indicated in subjects who are paralysed or extremely weak diaphragms but with good abdominal and accessory muscle strength. The procedure includes contraction of abdominal muscles tightly followed by its relaxation. Muscle contraction increases abdominal pressure pushes the

diaphragm to unusually high position in thorax. When abdominal muscles are relaxed the diaphragm passively falls to produce expiration accessory muscles can assist with this inspiratory effort to produce greater tidal volume. The disadvantages are every time to breathe in a conscious effort is necessary, subject must be in upright position to provide this exercise and subjects require mechanical ventilation during lying and sleep [9].

Any individual with paradoxical breathing or a poorly expanding chest wall during inspiration should learn to perform an airshift maneuver. When an individual has a dominant diaphragmatic breathing pattern that results in collapse of the anterior chest wall (as occurs in those with C4-T4 motor complete injuries), the volume of air moving into lungs does not act to expand the chest wall but instead moves in a caudal direction [15] An air shift is a maneuver in which a person inhales maximally, closes the glottis and relaxes the diaphragm to the individual to move the air upward toward the middle and upper lobes of the chest and creates expansion of these regions. Practice with opening mouth. It can potentially expand the chest from half to 2 inch. Position the patient in supine lying. Ask the patient to take deep breath and hold that breath. While holding the breath, therapist asks the patient to suck in the abdomen so that air will move from lower part to upper part of thorax. Instruct the patient to perform this exercise daily. With Airshift technique, chest mobility can be maintained for subjects who are with good chest wall range of motion and intercostals muscle weakness. The uses are to increase ROM of chest and a method of learning laryngeal control. As both Airshift and stacked breathing techniques used for achieving laryngeal control, they can be used for better effectiveness of cough. Air shift Maneuver can be used also for generalized collapses. The possible complications are consequences associated with breath holding and hyperventilation. To avoid this, individual should exhale between attempts and should rest frequently in the training sessions [9, 18].

Chest mobility exercises and Belt exercises [8, 19] are used to prevent the formation of disabling adhesions between two layers of pleura. Chest mobilization exercises can be defined as any exercises that combine active movements of the trunk or extremities with deep breathing. They are designed to maintain or improve mobility of the chest wall, trunk, and shoulder girdles when it affects ventilation or postural alignment. These exercises are indicated mainly in Pleural disorders, especially after ICD removal for increasing mobility of one side of thorax and preventing adhesions between two layers of pleura. Procedure is such that ask the patient to bend away from affected side and expand that side during inspiration. Then, have the patient push the fisted hand into the lateral aspect of the chest, bend toward the tight side, and breathe out. Belt exercises serve the purpose same as that of chest mobility exercise where the difference is that reinforcement over the chest is given with the help of a rolled bed sheet. Belt exercises aid in increasing the mobility of lateral basal (unilateral & bilateral) and posterior basal segments.

Impaired airway clearance can be interrupted by mucolytics, nutrition, broncho dilators, anti-inflammatories, antibiotics and airway clearance techniques. Airway clearance techniques or bronchial hygiene therapy includes traditional methods like coughing, huffing and manual drainage techniques such as postural drainage, percussion, vibration & shaking where as newer methods includes Mechanical devices like high frequency oscillation, positive expiratory pressure mask, flutter valve, intrapulmonary percussive ventilator & Breathing strategies such as autogenic drainage(AD) and active cycle breathing technique(ACBT). They foster independence because once taught they can be used without assistance. They are suited for the people with chronic lung problems. ACBT consists of three phases breathing control, thoracic expansion and forced expiratory technique (FET). FET consists of low huffs and high huffs interspersed with breathing control. AD is a Method of controlled breathing in which patient adjust the rate location and depth of respiration. It can be of Belgian approach and German approach. Belgian approach is divided into three phases such as unsticky phase, collecting phase and evacuating phase where as German approach has only one phase [20].

In patients with obstructive disorders there will be reduction of flow rate and increase in residual volume & total lung capacities. They predominantly use accessory muscles so work of breathing is increased. So goals of the management are to change the breathing pattern, reduce work of breathing and use more of energy conservation techniques. These types of patients have a period of acute exacerbation followed by their stable phase. Breathing Control Technique, Innocenti Technique, and Pursed Lip Breathing is used during acute exacerbation and End – Expiratory, Buteyko Breathing, Exhale with Activity, Stressed Respiratory Exercises, Panting, Pacing are commonly used when the subjects are in stable phase. Breathing control is synonymous with diaphragmatic breathing. But the only difference is that in diaphragmatic breathing, it is done with maximal inspiration where as in breathing control technique is performed at normal tidal volume. The application of breathing control technique includes its use along with FET and to control breathlessness. Pursed Lip breathing exercise (PLB) stresses on expiration therefore it can be used to control breathlessness and to reduce work of breathing. It keeps airways open by creating back pressure in the airways. The procedure is such that subject loosely purse the lips and exhale (like blowing out a match stick or candle). PLB decrease respiratory rate, increase tidal volume, improves exercises tolerance. It can be active and passive. PLB with forceful Expiration can increase turbulence in airways and cause further restriction. Innocenti technique aimed to prevent forceful expiration there by reduction of excess energy consumption and improves expiratory flow. Procedure is that at each breath instructs the subject to inhale just before abdominal muscle recruitment. This allows smooth transition from inspiration to expiration practice first with physiotherapist voice then without. It helps to prevent airway shutdown consumes less energy than pursed lip breathing thereby improving PaO2 [6].

End – expiratory hold mimics as that of Buteyko breathing. This technique is performed by slowing respiratory rate with breath counting and at night, lying on left side and taping mouth closed. The hold at the end of expiration elevates $PaCO_2$ which helps in broncho dilatation during stable phase. This technique reverses the symptoms, lessens the need for medication and prevents asthma attacks. Tension due to fear and anxiety prevents full relaxation of muscles of inspiration, therefore FRC is not attained. So Stressed Expiratory exercises can be given to these types of subjects. It can give also to aid clearance of secretions. Also this exercise allows identifying presence of secretions from the sounds. The unwanted side effect can be production of low lung volume. There are two types of stressed expiratory exercises. The first type is high volume high velocity where subject can do either relaxed expiration to FRC from VC (no real forcing of expiration) or Panting where subjects inhale to VC , briefly exhale forcefully

at high lung volume, inhale to VC and repeat several times. The other type is Low volume (similar to Huff) High or low velocity. In this technique subjects will Inhale to VC and exhale without inhaling 3-4 times down to RV [7].

Pacing is a technique where breathing is coordinated with activity. This can decrease WOB and relieve dyspnea during activity. Subject and therapist simply test different inspiratory to expiratory ratios with various activities like Cycling, walking, stair climbing until they find the rate and pattern that lower RR, relieves dyspnea and possibly improves SaO2. Exhale with effort is employed only in most severely impaired subjects or those with greatest complaints of dyspnea. The procedure for this technique is to teach the subjects to break any activity into one or more breaths (bending, lifting, getting out of bed). Then Steps are, inhale during rest with Diaphragmatic breaths, Exhale through pursed lips during activity, Repeat sequence. Stopping of motion during inspiration and continuing until activity is accomplished [3].

Inspiratory muscle training can be classified as low pressure high flow loading or high pressure low flow loading. In low pressure high flow loading also called as Normocapneic hyperpneic training increase the rate of breathing without altering $PaCO_2$ value. In this technique subjects were asked to breath at the highest rate they can manage for 15- 30 minutes. A rebreathing circuit (polyethene bag, face mask) or addition of CO2 to inspired air must be used to prevent hypocapnia. The purpose is to increase endurance of respiratory muscles. High pressure low flow loading can be of two types Inspiratory resistive training or Inspiratory threshold training. The Purpose of Inspiratory Resistive training is that to increase strength and endurance of Respiratory muscles. In this method the subject inhales through the tube of varying diameter. If diameter is narrow, there will be more resistance in the tube. First use the tube with greater diameter then gradually reduce the diameter. Limitation of this method is that there will be unreliable training loads if flow is controlled. In Diaphragmatic training using weights mechanical resistance will be given for diaphragm muscle for the subjects with cervical and high thoracic lesions. Subject placed in supine position. Weight pan is placed over the epigastric region. Subjects with neurologically intact diaphragm can usually start with 5 pounds. If a subject begins to use sternocleido mastoid, weight should be decreased [3].

Breathing cycle technique is used in subjects with chronic hyperventilation syndrome where there are no organic causes. Low level of CO_2 produces systemic effects such as palpitation, tachycardia, breathlessness, dysphagia, dizziness muscle pain; head ache etc. In this technique there will be history of emotional disturbance. A sequence of instructions will be given. In out in out in out, In out and in out and in, In out two three in out two three, In and out two three in and out, In and out two relax hold wait in and In one two out two three four five and in one two out. The inclusion of instructions such as “and” and numbers make the patient calm down from breathlessness there by relieving from breathlessness [19].

Suggested sequence for administering breathing exercises

1) Assessment: Assess for any indication for breathing exercises as mentioned before.
2) Preparation for breathing exercises-Patient should be relaxed position. Prior to teaching breathing exercises, perform bronchial drainage if required. The subjects can be given broncho dilators through nebulisation and humidification if required. Humidification to counteract dry atmosphere and dehydration Analgesics may be prescribed, if pain is inhibiting deep breathing.
3) Choice of breathing patterns. Normally subjects predominantly use apical pattern. So stress lateral costal and diaphragmatic breathing or a combination. Unilateral breathing exercise can be given in case of lobectomy. Manual contact is given to provide extraceptive input and proprioceptive input. Also assist expiration by assisting the downward and inward movement of chest wall. In subjects with mild chronic disease or those after acute exacerbation, who are using accessory muscles, their use must be discouraged. In subjects with severe lung impairment or those with acute exacerbation, therapist should not attempt to alter the pattern.
4) Choice of starting position: If no dyspnoea present, position should allow for freedom by movement of diaphragm and rib cage and also allow the subject to concentrate on breathing. The arms relaxed by sides to prevent tension in Thoraco-humeral muscles. Lumbar spine flattened and abdominal wall relaxed as in half lying, sitting crook lying half lying. Choose position which allows for greatest excursion of diaphragm. In supine lying greater resistance of weight of abdominal viscera which may be present if subject is horizontal or tipped head down. Gravity tends to assist descend of diaphragm in the upright position but it is only capable of small excursion since it is already very low in position. In side lying, isolation of lateral costal expansion is possible for upper most lungs. Diaphragmatic breathing in side lying will preferentially distribute inspired air to dependent lung. If dyspnoea is present, ensure relaxation of abdominals by hip flexed sitting assisted by gravity the descend of diaphragm during inspiration, Increase activity of neck extension than neck flexors compresses viscera and pushes a low diaphragm up enhancing its potential for improved excursion. Perfusion will be more in the upper lobes in tipped position improves V/Q matching which is helpful in pan lobular emphysema, which affects lower lobe. Lying supine flat tipped down to maximum of 15 to 20 degree puts diaphragm at higher level to improved excursion counteracted by air trapping which prevents upward movement reduces advantage. Tip of more than 20 degrees produces more weight on the diaphragm which further reduces by ascites and obesity [7].

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